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(71) Applicant(s)
Tomy Company Limited

(Incorporated in Japan)

9-10 Tateishi 7-chome, Katsushika-ku, Tokyo, Japan

(72) Inventor(s)
Akio Ozawa

(74) Agent and/or Address for Service
W P Thompson & Co
Coopers Building, Church Street, LIVERPOOL, L1 3AB, United Kingdom

(54) Toy vehicle.

(57) A toy vehicle (3 Fig. 1) having a body, a motor (M1 Fig. 4) and power source within the body, first and second wheels 10, first and second shafts 11 attached to the first and second wheels, said shafts 11 being mounted to the body for rotating movement and as well for vertical movement e.g. in a seesaw vertical direction, a differential gear 12 including a ring gear 14 operatively connected to the first and second shafts 11, a drive shaft 22 operatively connected to the motor (M1 Fig. 4) and provided with a first gear 20i connected to the ring gear 12, a second gear 30a provided on the drive shaft 22, a third gear 30b provided on the first and second shafts 11, the second and third gears 30a, 30b normally not meshing with each other, such that when the vehicle hits a bump, the upward movement of one of the first and second shafts 11 along the seesaw vertical path causes the second and third gears 30a, 30b to mesh causing the first or second shaft 11 associated therewith to rotate forcibly.

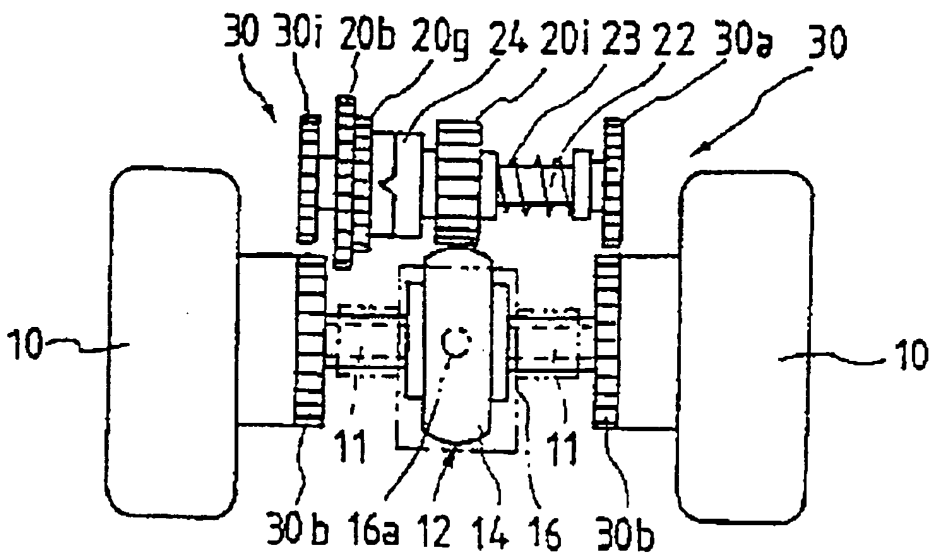

Fig. 6

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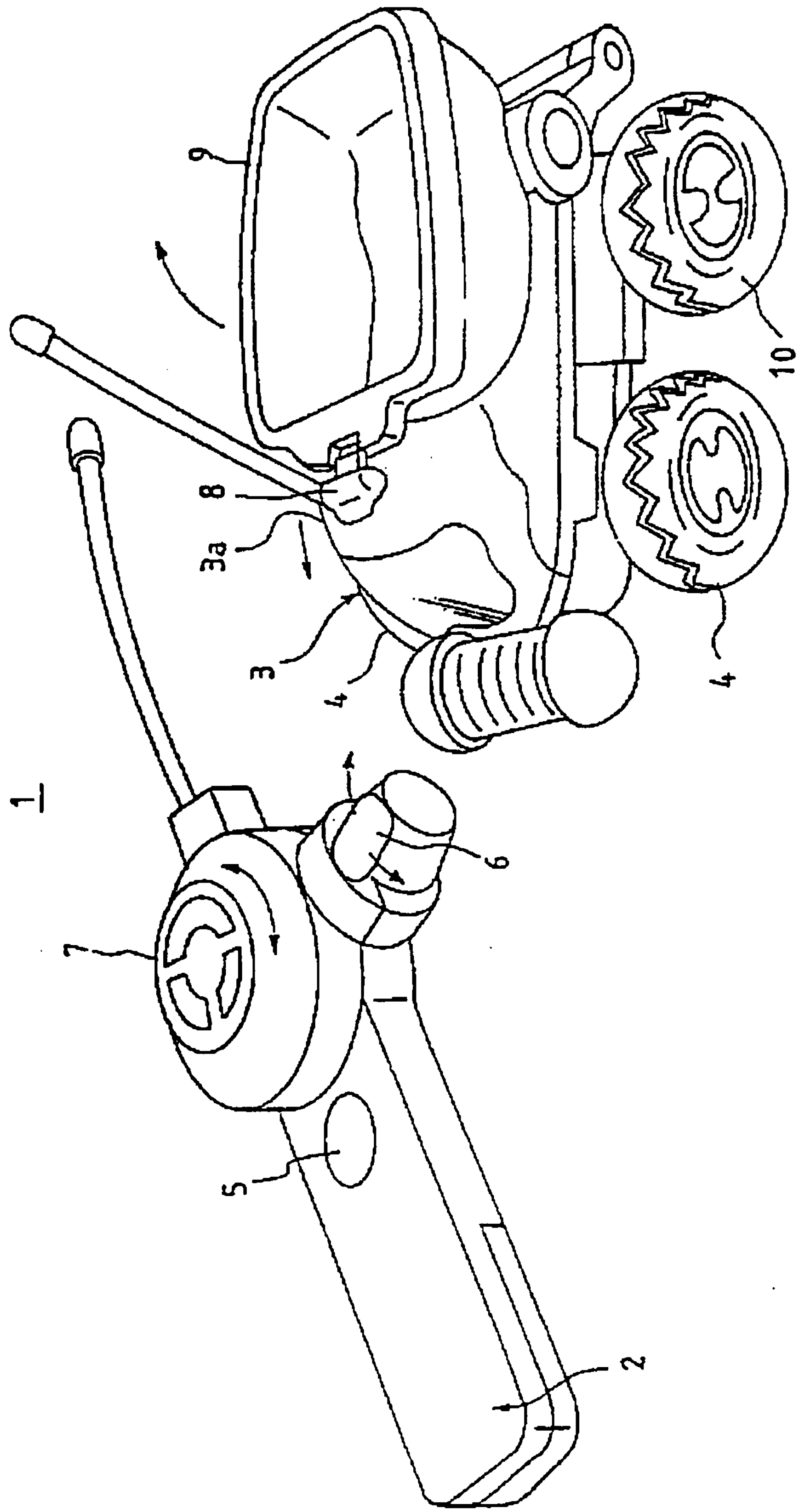
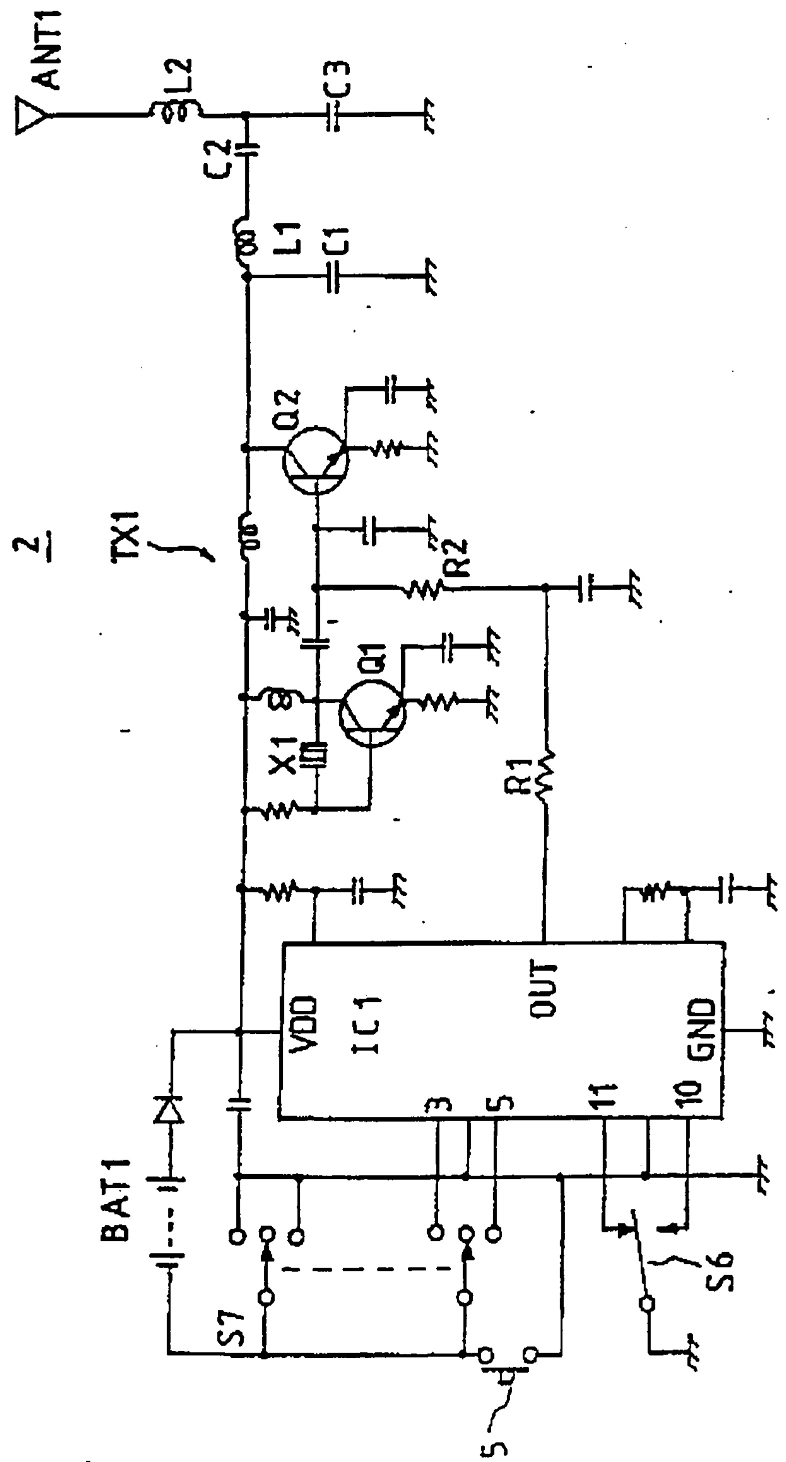


Fig. 1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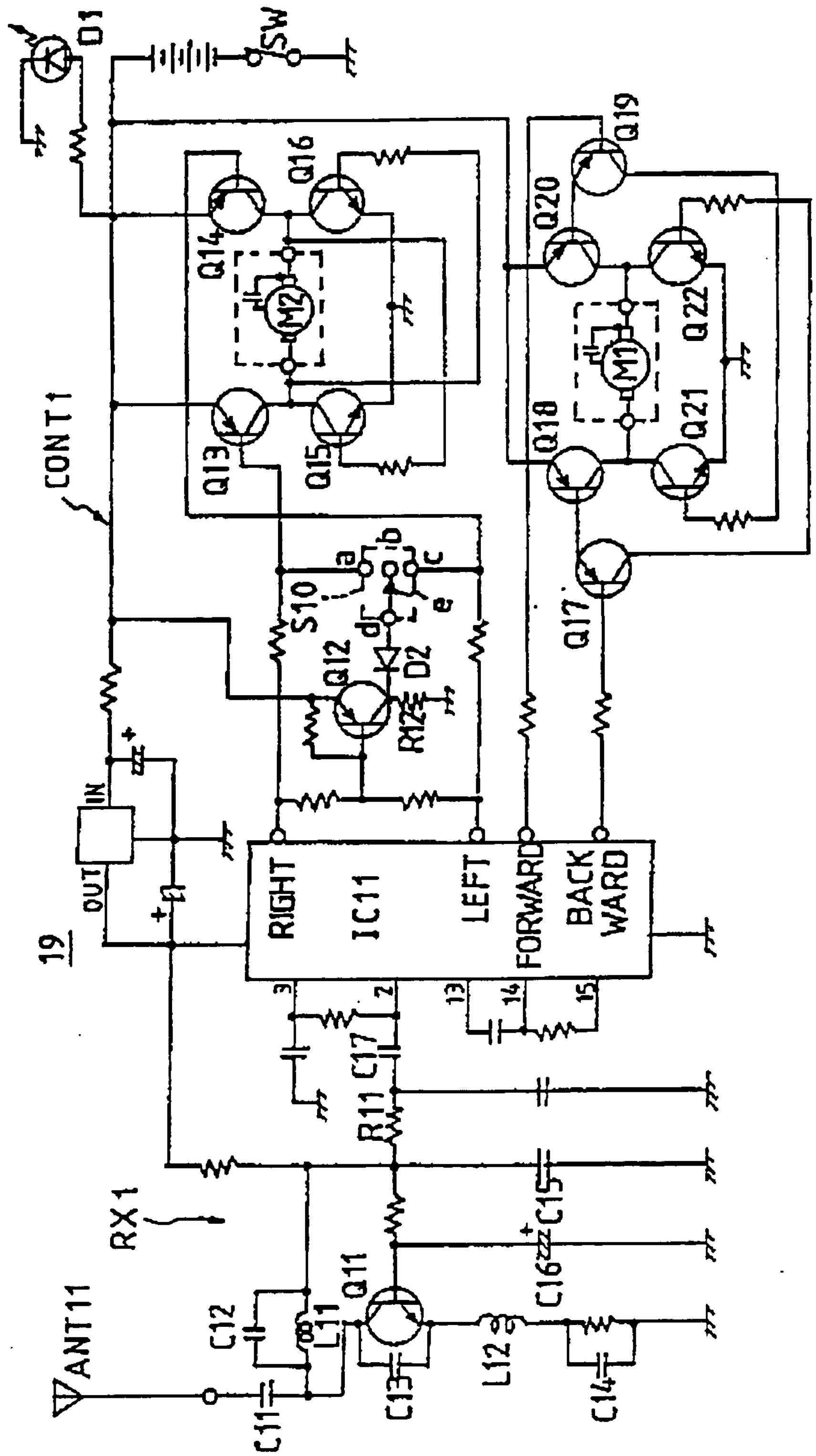
C3
C2
L1
C1
Q2
2
TX1
R2
Q1
X1
R1
IC1
VDD
OUT
GND
3
5
11
10
BAT1
S7
S6
5

Fig. 2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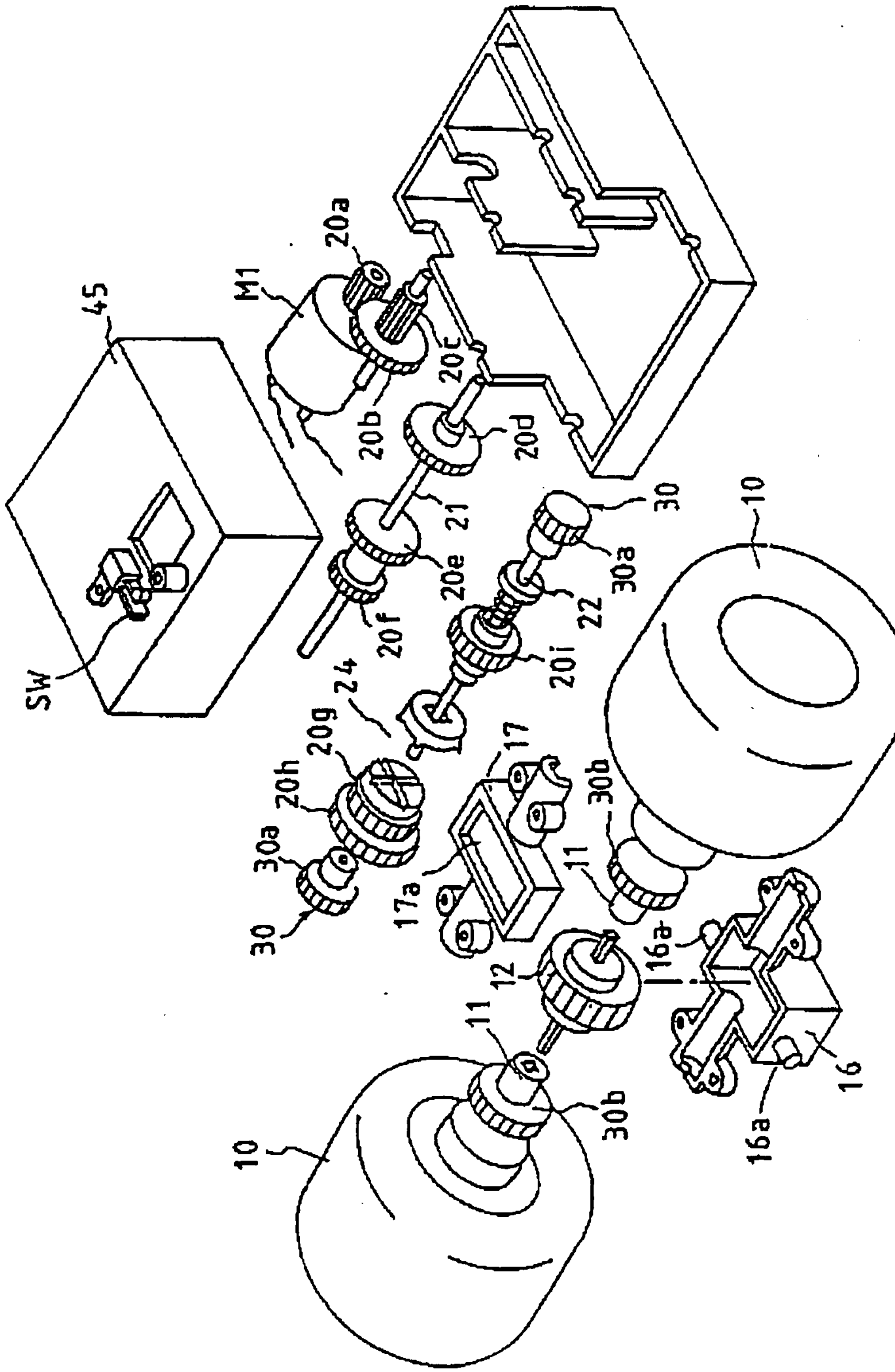
SW
CONT1
Q13
Q14
Q15
Q16
M2
Q17
Q18
Q19
Q20
Q21
Q22
M1
S10
a
b
c
d
e
Q12
D2
R12
19
OUT
IN
RIGHT
IC11
LEFT
FORWARD
BACK WARD
RX1
ANT11
C11
C12
C13
C14
C15
C16
C17
L11
L12
R11
Q11

Fig. 3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SW
M1
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20b
20c
20d
20e
20f
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30
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22
20i
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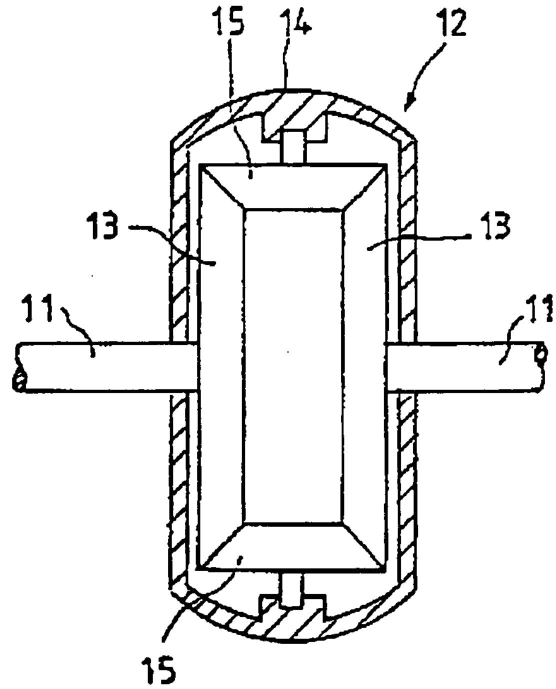
30b
16a
10

Fig. 4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14
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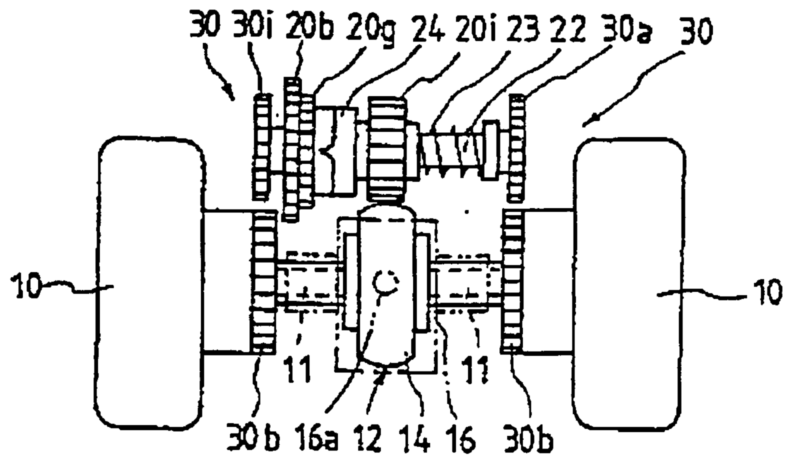
Fig. 5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30i
20b
20g
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30a
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30b
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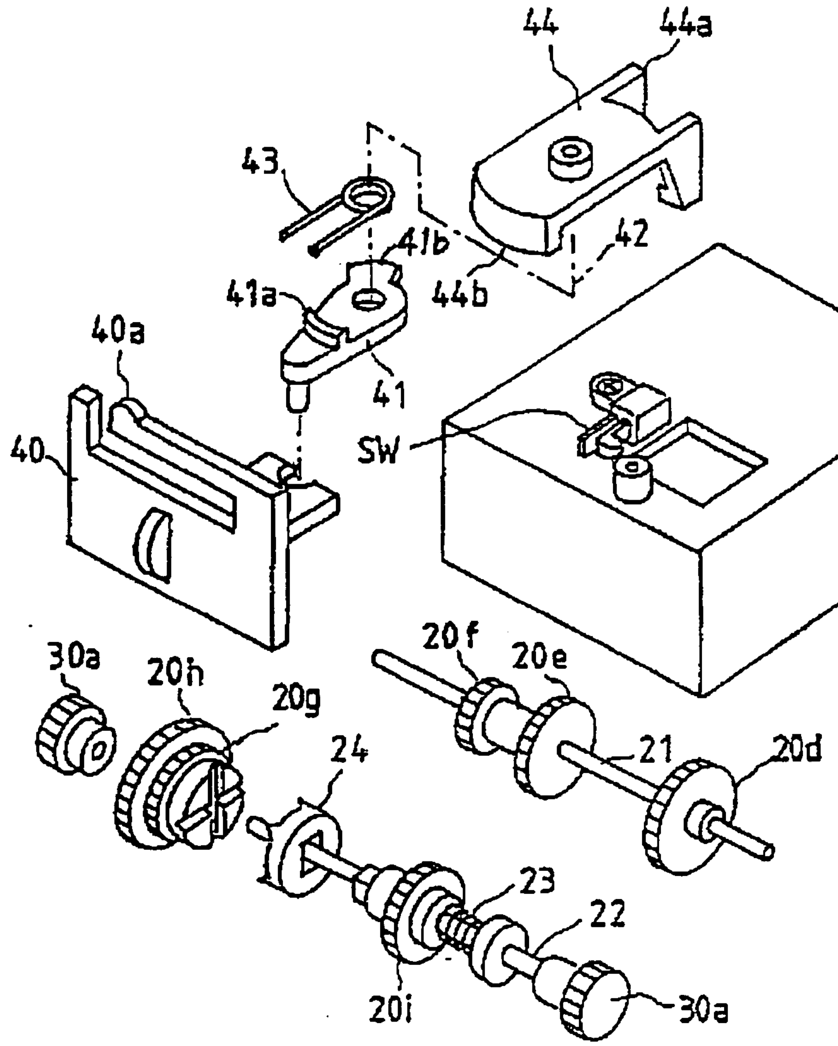
16
30b

Fig. 6



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44a
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41b
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41a
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40a
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20g
20f
20e
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24
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20d
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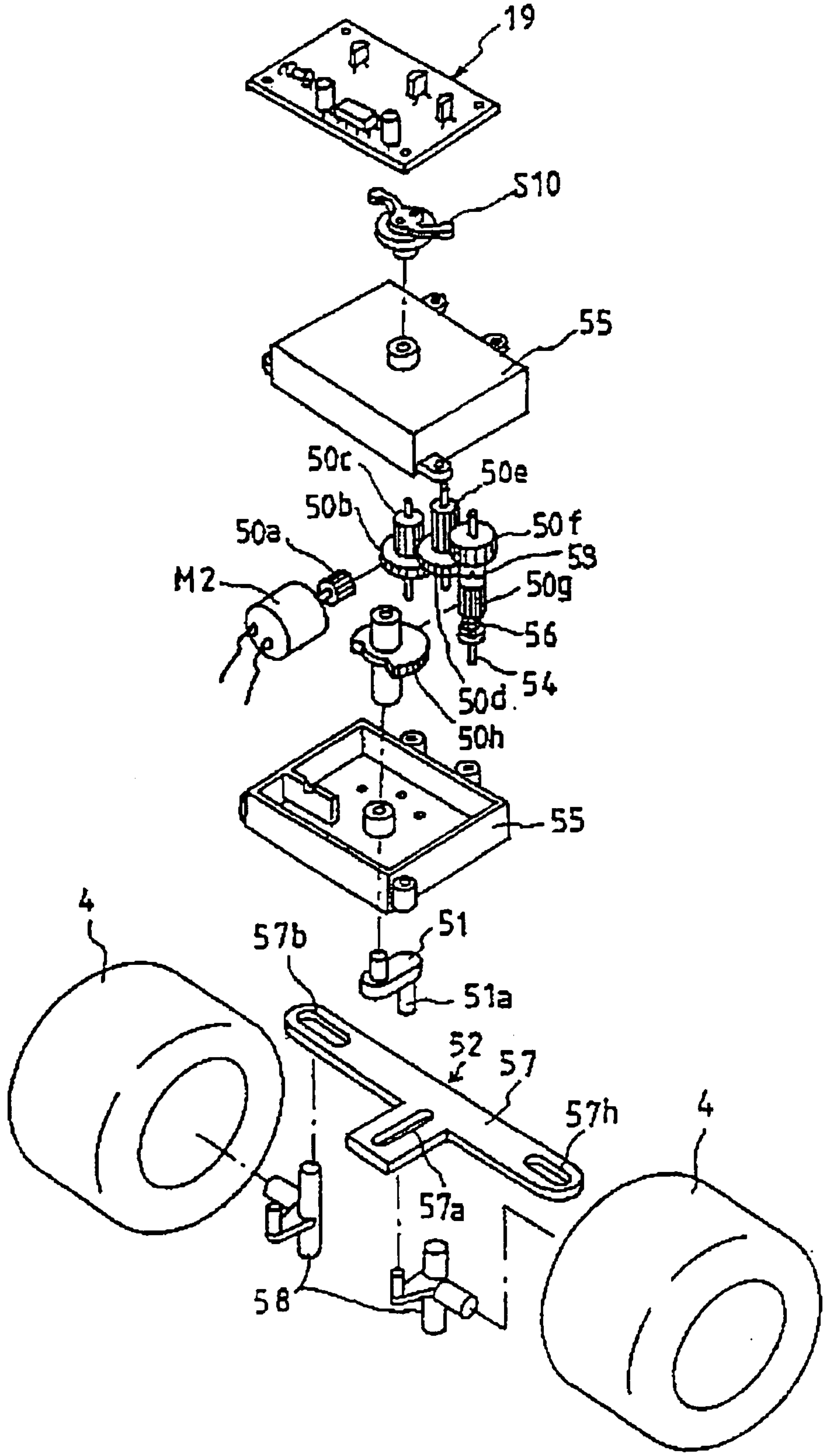
22
20i
30a

Fig. 7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50c
50e
50b
50f
50a
53
M2
50g
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50d
50h
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4
57b
51
51a
52
57
57h
4
57a
58

Fig. 8

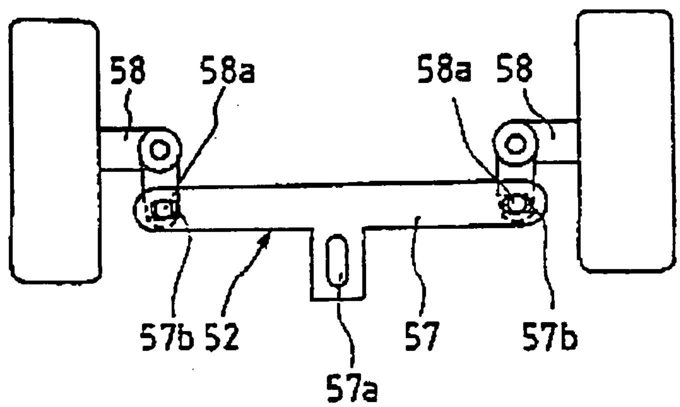

Fig. 9

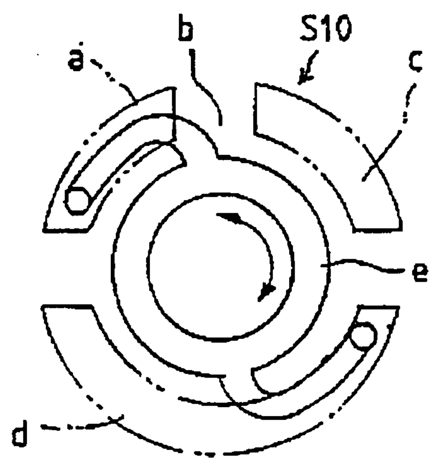

Fig. 10

DESCRIPTION

TOY VEHICLE

The present invention relates to a toy vehicle featuring right and left wheels steered by a differential gear and emergency train gears mounted on the shafts which force rotation of a wheel dislodged by a bump such that the wheel automatically resets itself without manual assistance.

In the prior art there are known toy vehicles with wheels which rotate at the same speed. This causes difficulty when the vehicle turns because typically the steering mechanisms are not constructed to compensate for the different speeds at which the wheels rotate when the vehicle moves along a curved path.

On the other hand, where toy vehicles in the prior art have been provided with differential gears to permit different rotational speeds of the wheels when negotiating a curve, the small size of the toy vehicle body easily causes the wheels to dislodge when there is even a slight bump. Because the relative speeds of the wheels then go out of balance, the dislodged wheel can not right itself and the player is required to reset the wheel manually. Such manual operation detracts from the advantage of the remote control capabilities of the vehicle.

The present invention features a toy vehicle with wheels which reset themselves when dislodged by a bump, thereby enabling the vehicle to be completely operated by remote control.

In the vehicle of the present invention, the right and left driving wheels are driven through a differential gear,

the right and left driving shafts on which the wheels are mounted and which are connected to side gears of the differential gear can move linearly e.g. upwardly and downwardly, a driving gear for rotating a ring gear of the differential gear meshes at all times with the ring gear and a shaft is placed near the right and left driving shafts. Emergency gear trains are mounted e.g. in the shaft and the right and left driving shafts, thus forcing one of the driving shafts to rotate forwardly and backwardly during the upward and downward motion of the vehicle.

In the vehicle of the present invention, the differential gear causes both driving wheels to turn at the same speed while traveling forward. However, on a curve the force of the outside wheel increases automatically in proportion to the resistance of the inside wheel such that the curve is negotiated smoothly. When a wheel is dislodged and does not touch the road surface, the emergency gear trains rotate the driving shaft on which the wheel is mounted causing the wheel to rotate while the other wheel continues to rotate through the differential gear. The dislodged wheel is thereby reset.

By way of example only, specific embodiments of the present invention will now be described, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view illustrating the vehicle and remote control unit of the present invention;

Fig. 2 is a circuit diagram of the controller of the present invention;

Fig. 3 is a circuit diagram of the receiver of the vehicle of the present invention;

Fig. 4 is an exploded perspective view illustrating the components of the rear wheel driving mechanism of the vehicle of the present invention;

Fig. 5 is a sectional view of the differential gear of the vehicle of one embodiment of the present invention;

Fig. 6 is a sectional view of the gear mechanism of the rear wheel drive of one embodiment of the present invention;

Fig. 7 is an exploded perspective view of the transmission of the vehicle of one embodiment of the present invention;

Fig. 8 is an exploded perspective view of the front wheel driving mechanism in the vehicle of one embodiment of the present invention;

Fig. 9 is a plan view of the front wheels of the vehicle and the steering mechanism connected therewith of the vehicle of the present invention; and

Fig. 10 is a schematic view of the steering center switch of the vehicle used in one embodiment of the present invention.

An embodiment of the toy vehicle of the present invention will now be described with reference to the drawings.

As seen in Fig. 1, the toy vehicle 1 consists of a controller 2 which issues a control signal and a vehicle 3 configured as a dump truck and containing a receiver 19 (Fig. 8) which is controlled by a signal from the controller 2. A switch SW of the dump truck 3 is turned ON afterwhich a button 5 is depressed causing the dump truck 3 to move forward. The lever 6 can be lowered toward the front or the rear of the dump truck 3 causing the vehicle to move forwardly or

backwardly, respectively. The handle 7 can be turned left or right, causing the dump truck 3 to respectively turn left or right. If the handle 7 is turned when the button 5 has not been depressed, the front wheels 4,4 are turned in the direction of the handle. The lever 8 on the roof 3a of the dump truck 3 raises the load-carrying deck 9.

As can be seen in Fig. 2, the controller 2 consists of an integrated circuit IC1 which controls forward and backward movement and left and right turns of the dump truck 3, and a transmitter circuit TX1 which transmits signals from the integrated circuit IC1.

A handle switch S7 is connected to input terminals 3 and 5 of the IC1. When the handle switch S7 is operated by the handle 7 so as to cause a left or right turn of the front wheels 4,4 of the dump truck 3, an earth signal is fed to input terminal 3 or 5 and an earth side of a battery BAT1 is grounded, starting the controller 2. Further, a switch S6 for changing between forward and backward movement is connected to input terminals 10 and 11, and when the switch S6 is operated by lever 6, an earth signal is fed to input terminal 10 or 11. When the button 5 connected between the minus and earth sides of the battery BAT1 is depressed, the minus side of the battery BAT1 is grounded and the controller is started. The controller 2 can start only when the handle 7 or the button 5 is operated, afterwhich the integrated circuit IC1 transmits from its OUT terminal a pulse control signal, corresponding to the signals transmitted to input terminals 3, 5, 10 and 11, to the transmitter circuit TX1. The pulse control signal consists of a start bit signal and a control bit signal. A

time interval between the start bit signal consisting of a high-level signal (hereinafter, H signal) of a predetermined duration, e.g., 3mSec, and the control bit signal consisting of an H signal of the same duration are set to the time required for movement of the dump truck 3.

The transmitter circuit TX1 consists of a crystal oscillator circuit comprising a transistor Q1, a crystal X1, etc., a modulation circuit using transmitter Q2, and a BPF (band-pass filter) comprising capacitors C1 to C3 and coils L1,L2. The crystal oscillator circuit generates a carrier wave of 27 Mhz, and an output signal is continually transmitted therefrom to the base of the transistor Q2. Transistor Q2 of the modulation circuit is turned ON by a pulse signal transmitted from the OUT terminal of the integrated circuit IC1 to the base of the transistor Q2. Thus, the transistor Q2 transmits the carrier wave transmitted from the crystal oscillator circuit to the BPF only when the pulse signal is an H signal, afterwhich the carrier wave is transmitted from the antenna ANTI through the BPF to the receiver 19.

The receiver 19 includes a reception circuit RX1 consisting of a transistor Q11, etc., and a motor control circuit CONT1 consisting of an integrated circuit IC11, transistors Q12 to Q22, etc. When the switch SW of the receiver 19 is turned ON, an LED light indicates that the receiver 19 is operational and electric power is supplied to the reception circuit RX1 and the motor control circuit CONT1 thereby starting operation.

In the reception circuit RX1, a transmitted wave transmitted from antenna ANT11 is demodulated into the pulse signal by means of a super-regenerative receiver circuit consisting of a transistor Q11, capacitors C11 to C16 and coils L11,L12, which signal is then transmitted to the input terminal 2 of the integrated circuit IC11 in the motor control circuitry CONT1 through resistor R11 and capacitor C17.

The integrated circuit IC11 amplifies and shapes the transmitted pulse signal, then divides it into the start bit signal and the control bit signal, and in coordination with the interval time between the two signals, the pulse signal is decoded by a pulse controller circuit and decoder circuit contained in the IC. Based on the decoded signal, a predetermined control signal is transmitted from an output control circuit incorporated in the integrated circuit IC11. A low level signal (hereinafter L signal) is transmitted from terminals FORWARD for forward movement, BACKWARD for backward movement, LEFT for a left turn and RIGHT for a right turn. The L signal is transmitted continually while the corresponding switch is pushed in the controller 2.

When an L signal is transmitted from terminal FORWARD, the transistors Q19 to Q21 turn ON to drive a motor M1 forward, and when the L signal is transmitted from terminal BACKWARD, transistors Q17, Q18 and Q22 turn ON reversing the motor M1.

When an L signal is transmitted from terminal LEFT, transistors Q14,Q15 turn ON operating a motor M2 whereas an L signal transmitted from terminal RIGHT causes transistors Q13 and Q16 to turn ON reversing the direction of the motor M2.

As shown in Fig. 4, rear wheels 10,10 of the vehicle are driving wheels mounted on shafts 11,11 and interconnected through a differential gear 12 placed therebetween.

As shown in Fig. 5, the differential gear 12 consists of a ring gear 14 for input and side gears 13,13 which constitute the sun gear connected to driving shafts 11,11, respectively, and planetary pinions 15,15 which mesh with the side gears 13,13. When movement is backward or forward, the ring gear 14 rotates and the planetary pinions 15,15 revolve around the side gears 13,13 without rotating on their own axes, causing the driving shafts 11,11 to rotate at an equal speed. On a curve, to compensate for the greater surface resistance of the inside rear wheel 10, the planetary pinions 15,15 revolve around the side gears 13,13 while rotating on their own axes, and the driving shafts 11,11 rotate at different speeds. The rotational speed of the inside driving shaft 11 becomes less than its speed during forward movement, and the speed of the outside driving shaft 11 becomes greater, causing the dump truck 3 to negotiate the curve smoothly.

The differential gear 12 is placed within a gear box 16. The driving shafts 11,11 are constructed to move upwardly and downwardly within the dump truck 3, centered on shafts 16a,16a projecting from the front and rear sides of the gear box 16. The fulcrum of the upward and downward motion, i.e., the shafts 16a,16a, is centered in the transverse direction of the dump truck 3. A lid 17 on the gear box 16 has an opening 17a exposing part of ring gear 14.

The mechanism for driving the differential gear 12 will now be described. The rotational force of motor M1 is

transmitted to a shaft 21 through gears 20a, 20b, 20c and 20d. The shaft 21 is movably supported in the direction of its axis, and gears 20d, 20e and 20f are mounted on the shaft 21. A gear 20g capable of meshing with the gear 20e, and a gear 20h capable of meshing with gear 20f, are mounted on a parallel shaft 22. The gears 20g and 20h are integrated with each other and the gears 20e and 20g and the gears 20f and 20h alternately mesh with each other. The rotational force transmitted to the shaft 21 is now transferred through either the gears 20e and 20g or the gears 20f and 20h to a driving gear 20i on shaft 22 and transferred therefrom to the ring gear 14 of the differential gear 12. The driving gear 20i, which does not engage the shaft 22, is propelled against the gear 20g through a surface clutch 24 by a spring 23, whereby the driving gear 20i can be rotated in coordination with the gears 20g and 20h. The surface clutch 24, placed between the gears 20i and 20g and in which opposite concave and convex surfaces are fitted together, transmits the rotational force of the gears 20g and 20h to the side of the driving gear 20i. For example, when excessive weight is placed on the rear wheels 10,10, the surface clutch disengages the gears 20g,20h and the gear 20i from each other.

Emergency gear trains 30,30 are mounted on the driving shafts 11,11 and the shaft 22. The gear trains 30,30 consist of gears 30a,30a on both ends of the shaft 22 and gears 30b,30b on the driving shafts 11,11 on both sides of the differential gear 12. As shown in Fig. 6, on a level surface the gears 30a,30a and the gears 30b,30b do not mesh with each other. When a bump is hit and a wheel is dislodged, the

upward and downward motion of the driving shafts 11,11 causes the gear 30b on the upwardly moving side to mesh with corresponding gear 30a. Since the gear 30a is affixed to the shaft 22 and is rotated by the force of the gears 20g and 20h, the differential gear 12 is propelled by both the driving gear 20i and the gear 30a. The force from the gear 30a is calculated to be less than that required to cause forward movement of the driving shaft 11. In this embodiment, the ring gear 14 is expanded such that the driving gear 20i and the ring gear mesh with each other during the upward and downward movement of the driving shafts 11,11.

The transmission mechanism within the driving mechanism includes the gears 20e and 20f mounted on the shaft 21 and gears 20g and 20h mounted on the shaft 22. The gears 20e and 20g mesh alternately with gears 20f and 20h. A lever 41 is pivotably moved about a shaft 42 by turning a sliding switch 40 to the right or left. A lever 44 is then pivotably moved about the shaft 42 through a coiled torsion spring 43, and by moving the gear 20d, which is gripped by a fork 44a attached to one end of the lever 44, to the right or left, either the gears 20a and 20g or the gears 20f and 20h alternately mesh. An elastic pawl 40a on the upper surface of the sliding switch 40 engages a recess (not shown) of the dump truck 3 to maintain any of the aforesaid meshing positions. The levers 41 and 44 engage each other by retaining the ends of the coiled torsion spring 43 wound around the shaft 42 to ends of upper surfaces 41a and 44b of the levers 41 and 44, respectively. A main switch SW2 in the dump truck 3 is turned

ON and OFF in coordination with the sliding switch 40. A pressing lug 41b of the lever 41 turns the main switch SW1 in a box 45 ON and OFF.

In the steering mechanism of Fig. 8, the rotational force of the motor M2 is transmitted to a link 51 through gears 50a, 50b, 50c, 50d, 50e, 50f, 50g and 50h, the motor and gears being located within a box 55, and therefrom to quadric crank chain 52, thereby steering the front wheels 4,4. A surface clutch 53 is placed between the gears 50f and 50g. The gear 50g does not engage the shaft 54 but rather is propelled against the gear 50f through the surface clutch 53 by a spring 56, thereby coordinating the rotation of gears 50f and 50g with each other. The opposite convex and concave surfaces of the surface clutch 53 are fitted into each other and the clutch transfers the rotational force of the gear 50f to the gear 50g. When there is excessive pressure on the front wheels 4,4, the surface clutch 53 disengages the gears 50f and 50g. In the center of driving link 57 of the quadric crank chain 52 there is an elongated hole 57a extending along the length of the dump truck 3 with a pin 51a of the link 51 fitted in the elongated hole 57a. Holes 57b,57b are cut out in both ends of link 57, with pins 58a,58a of shaft members 58,58 which support the front wheels 4,4 fitted therein. In this embodiment, the front wheels 4,4 are steered by the forward and reverse rotation of the motor M2.

As shown in Figs. 3, 8 and 10, a steering center switch S10 regulates forward movement of the dump truck 3. When the front wheels 4,4 are turned in a right or left direction, the contact d of the switch S10 is connected to a contact a or c

on a stationary side by a movable contact e which is rotated integrally with the gear 50h. A steering center setting circuit consists of a steering center switch S10, the transistor Q12 as shown in Fig. 3, etc. This steering center setting circuit sets the front wheels 4,4 in a forward direction when the handle 7 has been returned to its original position after a left or right turn of the vehicle, or where the front wheels 4,4 are turned to the right or left when the switch SW of the receiver 19 is turned ON. In this circuit, when the contact d of the switch S10 is connected to the contact a or c, the base current of the transistor Q13 or Q14 flows through diode D2 or resistor R12 to turn the transistor Q13 or Q14 ON, and the motor M2 rotates forwardly or reversely until the contact d is no longer connected to contact a or b, i.e., the connection of contacts d and b in Fig. 3, or as shown in Fig. 10 one of the two ends (indicated by circles) of movable contact e is positioned in the gap b between the contacts a and c, or until the front wheels 4,4 are in a forward position. When the wheels 4,4 are forward or when the L signal is transmitted from the LEFT or RIGHT terminal of the integrated circuit IC11, the flow of the base current of the transistors Q13 and Q14 is stopped thereby stopping the motor M2.

Although the emergency gear trains 30,30 are placed between the shaft 22 with the driving gear 20i mounted thereon and the driving shafts 11,11 in the above embodiment, the gear trains may be placed in other locations, for example, between the driving shafts 11,11 and a shaft which is separate from the driving gear 20i.

It will be apparent that the present invention is not limited to the preferred embodiment disclosed herein and that various modifications may be made within the scope of the invention.

CLAIMS

1. A toy vehicle, comprising: a body, a motor mounted to said body, first and second wheels for powering the vehicle along a surface, first and second shafts attached to said first and second wheels, means mounting said first and second shafts to said body for rotating movement and also for movement in a linear direction, differantial gear means including a ring gear operatively connected to said first and second shafts, a drive shaft operatively connected to said motor and provided with first gear means operatively connected to said ring gear of said differential gear means, second gear means provided on said drive shaft, third gear means provided on said first and second shafts, said second and third gear means normally not meshing with each other, such that when the vehicle hits a bump, the movement of said first and second shafts along said linear direction causes said second and third gear means to mesh causing said first or second shaft associated therewith to rotate forcibly.

2. A toy vehicle as claimed in claim 1, wherein said linear movement of said first and second shafts is a seesaw vertical movement.

3. A toy vehicle as claimed in claim 1 or 2, wherein said second gear means includes two gears mounted on said drive shaft, and wherein said third gear means comprises separate gears mounted on said first and second shafts, said gears on said drive shaft normally not meshing with said gears on said first and second shafts.

4. A toy vehicle as claimed in any one of the preceding claims, wherein movement of said first and second shafts in a linear direction causes said wheel associated with said shaft to move away from the surface along which the vehicle is moving at which time the second and third gear means mesh rotating the shaft and wheel.

5. A toy vehicle as claimed in any one of the preceding claims, further comprising a hand-held control unit remote from the vehicle provided with means for issuing control signals, and wherein said vehicle is provided with a receiver controlled by the signal from the hand-held control unit.

6. A toy vehicle as claimed in claim 5, wherein said control unit includes integrated circuit means controlling the forward and backward movement of the vehicle and left and right hand turns thereof and a transmitter circuit for transmitting signals from the integrated circuit to the receiver of said vehicle.

7. A toy vehicle as claimed in any one of the preceding claims, which also includes a power source mounted to said body.

8. A toy vehicle as claimed in claim 7, wherein said power source is mounted within said body.

9. A toy vehicle as claimed in any one of the preceding claims, wherein said motor is mounted within said body.

10. A toy vehicle substantially as hereinbefore described with reference to and as illustrated in any of the accompanying drawings.

Patents Act 1977
.x. iner's report to the Comptroller under Section 17
(The Search report)

-16-

Application number
GB 9401731.6

Relevant Technical Fields

(i) UK Cl (Ed.M) A6S, F2D (DLA)

(ii) Int Cl (Ed.5) A63H 17/00,17/26,17/36, F16H 1/44

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE: WPI

Search Examiner
KARL WHITFIELD

Date of completion of Search
9 MARCH 1994

Documents considered relevant following a search in respect of Claims :-
1-10

Categories of documents

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Category	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

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